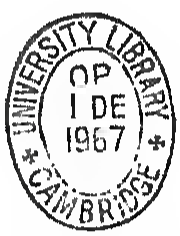
MINISTRY OF HOUSING AND
LOCAL GOVERNMENT

Working Party on the Design and Construction of Underground Pipe Sewers

Note of Guidance on Practical Considerations in the Structural Design and in the Construction of Small-diameter Sewers and Drains



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Note of guidance on practical considerations in the structural design and in the construction of small-diameter sewers and drains

Introduction

1. Defective drains and drain connections can be the cause of excessive infiltration of ground water to the main sewerage system and can also be the cause of pollution of ground water with consequent risk to sources of public water supply. They can result in much unnecessary expenditure of public money on the repair of connections, on the maintenance of sewers and on pumping and treatment of sewage. This note of guidance is intended to set out some of the matters which must be borne in mind in the structural design and construction of small-diameter drainage pipelines, which represent in length a very large proportion of the whole drainage network. It is directed particularly to those less experienced in this type of work. The recommendations in it apply especially to sewer and drain pipes of rigid and flexible materials of sizes up to and including 9 in. diameter. In preparing it the Working Party have particularly borne in mind the need to cater for the increasing mechanisation of sewer and drain construction and the resultant employment of a minimum of skilled labour. They consider that construction in accordance with the note will result in the practical and satisfactory laying of sewer and drain pipes in this size range. As the result of long-term trials still to be carried out and in the light of further field experience it may be possible to make less stringent the recommendations given in the appendix for the selection of soil material for bedding, side- and backfilling immediately around the pipe.

2. Rigid pipes such as asbestos cement, concrete, vitrified clayware and iron do not deform significantly under load; they are relatively brittle and crack or collapse when overloaded. In order that they may withstand the loads imposed on them it is essential that they be adequately and uniformly supported. Unless this is done the pipes may be subjected to localised loads in excess of those which they are designed to carry.

3. The properties that give flexible pipes (such as pitch fibre and plastics) and their joints their longitudinal flexibility may also result in excessive deformation or ovality of cross section unless care is taken during installation to ensure that the pipes are given adequate bedding and side support, since it is from these that the pipes principally derive their strength. With flexible pipes therefore it is of great importance that the sidefill should be very firmly compacted between the sides of the pipe and the soil sides of the trench. For the necessary horizontal reaction from the sidefill to develop it is necessary for some deformation or ovality of the pipes to take place. Until more is known on this subject the Building Research Station consider that the maximum acceptable decrease in vertical diameter is five per cent, because above this figure there is increasing risk of blockage, leakage at joints or collapse of pipes. With the granular material later described the decrease in vertical diameter will probably be considerably less than this figure. Whether five per cent is acceptable in any particular case must be for the design engineer to decide.

The choice of pipe and bedding materials for sewers and drains

4. The structural strength of a sewer or drain depends inter alia on the strength of the pipes and on the type of material on which they are bedded. For given conditions adequate strength can be provided by the use of any one of a number of combinations of pipe strengths and bedding materials.

5. The British Standard Specifications listed below give information regarding the different qualities and/or strength of pipe available in various materials.

	Material	British Standard Number
Rigid	Asbestos cement	3656: 1963
	Concrete	556: 1966 and 4101: 1967 (surface water)
	Clay	65 and 540: 1966
	Iron—cast	78: 1961 and 437: 1933
	Iron—spun	1211: 1958
Flexible	Pitch-impregnated fibre	2760: Pt. 1: 1966 and Pt. 2: 1967
	P.v.c. (unplasticized)	3506: 1962*

6. Rigid pipes may be laid on granular material, imported to the site or excavated from the trench, or on concrete. They may also be laid on the natural trimmed bottom of the trench, but the circumstances in which this is advisable are limited and are referred to in paragraphs 50 to 54. Flexible pipes should always be laid on granular material imported to the site or excavated from the trench. *Whatever bedding may be selected, it is necessary that workmanship be satisfactory and supervision adequate.*

7. Concrete bed, bed and haunch or surround may be required with rigid pipes of some strength classes in order to provide adequate structural strength. The necessity for such strengthening varies with pipes of different materials according to their strength classification and the depths at which they are to be laid.

8. The practical advantages and disadvantages of various bedding materials and the methods of construction associated with their use should be borne in mind in deciding on the type of pipe and bedding to be used, together with any difficulties likely to be encountered in the subsequent maintenance of a sewer or drain laid on a particular bedding. Reference is made later in this note to some of these advantages and disadvantages.

The choice of pipe length and type of joint

9. The use of pipes of the maximum length available in the particular diameter and material to be used reduces the number of joints to be made, which should reduce the cost of the pipeline and the risk of leakage. With longer pipes, however, in certain site conditions and with certain methods of bedding, these advantages may be offset by increasing difficulties in handling, laying, risk of fracture or other damage both during and after construction.

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* The British Plastic Federation's interim recommendation is that for drainage work Class 2 pipe should be used, or Class 3 in sizes where Class 2 is not available.

10. The maximum length of pipe should be used that can be easily handled and accurately bedded in the particular site and construction conditions of the work to be carried out.

11. Wherever possible mechanical joints* should be used in preference to cement mortar joints. They can be made quickly and easily and have the added advantage of providing flexibility in the sewer or drain. They allow the pipeline to be tested and the trench to be backfilled without delay.

12. However, until sufficient mechanically-jointed pipes become available it may be necessary to use cement mortar joints with pipes of some materials. Advice is therefore given in paragraphs 55 and 56 on the making of both types of joint. It is stressed that the use of cement mortar joints should be regarded only as an unavoidable temporary measure and it is hoped that in time the use of mechanical joints will become universal.

13. Most flexible lines of rigid pipes and lines of flexible pipes are capable of following ground movement of normal degree without fracture or failure, but for special cases of unstable ground and areas of mining subsidence, where "draw" of the joints may be expected, joints that permit telescopic movement should be employed throughout the line and they must be so installed as to permit contraction as well as expansion of the length of the line.

The construction of the sewer or drain

14. Certain precautions are necessary when any type of pipe is laid if subsequent trouble is to be avoided. The principal precautions are summarised here.

(a) Excavation

15. The trench should not be opened too far in advance of pipe laying and should be backfilled as soon as possible. The width of the trench at the crown of the pipe should be as narrow as praoticable, but not less than the outside diameter of the pipe plus one foot to allow proper compaction of the sidefill.

16. Except where the natural trimmed bottom is to be used, the trench should be excavated to the depth below the invert of the pipe that will allow the necessary thickness of bedding material. Before placing this bedding the trench bottom should be prepared. Mud arising from slurrying should be removed. All soft spots should be hardened by tamping in gravel or broken stone. Rock projections, boulders or other hard spots should be removed. In fine grained soils such as soft clays, silts or fine sand, disturbance of the bottom of the trench should be prevented by placing a layer of granular bedding material about 3 ins. thick or concrete at least 2 ins. thick (according to the bedding material to be used) on the virgin surface before permitting traffic in the trench. These precautions are especially necessary in bad weather and in bad or wet ground conditions.

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* Mechanical joints referred to in this note are joints with factory-made jointing materials; they are often called flexible joints.

(b) Handling the pipes

17. Great care should be exercised in handling the pipes from arrival on site to laying in the trench. Damage can arise from improper stacking; manufacturers' instructions on this subject should be strictly followed. Each pipe should be examined before laying to ensure that it is not cracked, badly chipped, distorted or otherwise defective; all unacceptable pipes should be removed from the site immediately.

(c) Bedding, laying and protecting the pipes

(i) *Imported granular material*
(for rigid and flexible pipes)

18. The use of imported granular material for bedding pipes helps to meet the need for increased mechanisation of sewer and drain construction in that accurate hand trimming of the trench bottom is unnecessary.

19. Granular beddings are by their nature flexible and where they are used to support rigid pipes the pipelines should be constructed with mechanical joints.

20. Granular material is easy to handle, it protects the trench bottom and enables construction to proceed in most weather and subsoil conditions. With mechanical joints backfilling of the trench can proceed immediately the sewer or drain has been laid and tested. The trench is open for a minimum of time and the length of the working area can be reduced to that necessary for adequate testing and inspection.

21. There is some risk of loss of granular material, and hence disturbance of the pipes and other services, if excavation at the same or a greater depth takes place immediately alongside the trench at a later date. There is a risk of the bedding acting as a permanent drainage channel for subsoil water unless suitable water stops are inserted.

22. Care is necessary in the choice and withdrawal of trench supports to ensure that granular bedding is not disturbed. Special care both in design and construction is necessary to ensure adequate support for junctions where granular bedding is used.

23. If granular bedding is not satisfactorily compacted there is risk of subsequent movement of the pipes from line and level. The extent of compaction necessary will vary according to the grading of the material. Some well graded materials can be adequately compacted without great effort. Poorly graded materials will require careful compaction.

24. Before deciding to use granular bedding it is necessary to be sure that suitable material is readily available. One of the most suitable materials is broken stone or gravel etc. from 3/8 to 3/16 in. in size since it requires little tamping, but coarse sand, or sand and gravel, or gravel from 3/4 in. down as it comes from the quarry is acceptable provided it complies with the tests described in the appendix to this note, which have been devised by the Building Research Station.

25. In wet fine grained soils coarse sand in the bedding reduces the intrusion of foundation soil into the voids. An excess of fine particles, however, makes

the mixture more difficult to compact when damp. Sands containing fine particles in sufficient quantity to impede drainage or cause bulking during construction should not be used.

26. Materials of other gradings can be used, provided that they comply with the requirements of the tests described in the appendix. If larger material than that referred to above is used, there is likely to be increased difficulty in laying the pipes accurately to line and level.

27. The bedding material should be carefully placed in the trench; rough handling may result in segregation and uneven grading. It should be evenly spread over the full width of the trench, any trench sheeting being partially withdrawn to allow this to be done. The thickness of the compacted bedding under the barrels of the pipes should be a minimum of 4 ins. In very soft or wet conditions or where the bottom of the trench is very irregular, this thickness should be increased as necessary to give a suitable bed.

28. The material should be compacted in layers not more than 4 ins. thick to give a uniform bed, true to gradient, on which the pipes may be laid. Wherever possible suitable machines should be used for compacting the bedding; where this is not practicable the material should be thoroughly hand tamped. The less well compacted the bedding, the greater will be the risk of subsequent settlement of the pipes.

29. Socket holes, where necessary, should be formed in the granular bedding but it is not necessary to excavate them in the natural trench bottom. They should be as short as practicable and sufficiently deep to prevent the sockets from bearing on the granular bed as the pipes are laid. On completion there should, however, be a minimum depth of 2 ins. of granular material beneath the sockets.

30. Pipes should be laid directly on the completed bedding. Bricks or other hard material must not be placed under the pipes for temporary support. Care should be taken to ensure that the barrels of the pipes are uniformly supported on the bed throughout their length, and that the bed is not disturbed whilst positioning the pipes true to line and jointing them. It is probably preferable to make final adjustments for line and level after a run of several pipes has been laid.

31. Where flexibility of the pipeline is essential because of the possibility of subsidence, for example in mining areas, particular care is necessary to ensure that movement at the joints of rigid pipes is not prevented by granular material finding its way into the gap between spigot and socket. The gaps should be sealed by any suitable means, such as the use of puddled clay or bitumastic putty immediately after jointing and before side- and backfilling are commenced.

32. After the pipes have been laid and tested further bedding material should be placed around them and be thoroughly compacted in approximately 4 in. layers as described for the bed. Care must be taken to eliminate all cavities under the two lower quadrants of the pipes, the trench sheeting being further withdrawn as the work is carried out. *For rigid pipes* the granular material should be carried at least halfway up the height of the pipes.

Selected excavated material, from which stones over 1 in. in size and lumps of clay have been removed, should then be carefully placed and compacted in 4 in. layers up to a minimum height of 12 ins. above the crown of the pipes. *For flexible pipes* the granular material should be carried up to a minimum height over the crown of the pipes of 4 ins. for pipes of 4 in. diameter and 6 ins. for pipes of 6 in. diameter and over and be thoroughly compacted.

(ii) *Excavated material*
(for rigid and flexible pipes)

33. In some cases the material excavated from the trench may be a granular material satisfactory for use as bedding, side- and backfilling immediately around the pipes. If so, the same comments apply as in paragraphs 18 to 32 except that greater care is necessary in selecting the excavated material to be used, because it is likely to be less uniform in quality and grading than specially imported material.

34. Only a limited range of soils will be suitable for this purpose, such as free-draining coarse sand, gravel and soils of a friable nature which are capable of being compacted sufficiently to provide support for the pipe. Clay should never be used; it is difficult to compact and is liable to shrink or swell. Soils such as hard chalk which break up when wet should not be used. The simple method for testing the excavated material referred to in paragraph 24 and described in the appendix to this note should be used to determine whether it possesses the requisite properties. Excavated material should be used for bedding only where it complies with the requirements of these tests.

35. The procedure for laying pipes on excavated material should be identical with that outlined for imported granular material.

(iii) *Concrete bed, bed and haunch and surround*
(for rigid pipes and for flexible pipes in special circumstances)

36. Concrete can be used to provide a positive, uniform and satisfactory bed for rigid sewer and drain pipes, but to provide adequate supporting strength it must be of satisfactorily controlled quality and be properly laid on a firm foundation under good supervision. Any relaxation may result in voids, especially under the pipes, with a consequent serious reduction in the supporting strength of the bedding.

37. The use of concrete reduces the risk of damage to the pipeline by subsequent excavations alongside the trench. The laying of pipes to accurate gradients is facilitated. In most cases the removal of trench supports is unlikely to affect the stability of the bedding.

38. Frosty weather is likely to delay construction where concrete is used, unless pre-heating methods are employed; such weather, however, is also likely to delay backfilling and the completion of construction whatever bedding is used. Construction can continue with concrete bedding in most other weather conditions, but maintenance of the quality of the concrete may be more difficult in very wet weather or subsoil conditions.

39. Where site access is not easy some difficulty may arise in transporting and placing the concrete in position in satisfactory condition, and care must be taken to ensure that partially set or otherwise unsatisfactory material is not used.

40. The concrete should be such as to provide a minimum works cube strength at 28 days of 3,000 lbs./sq. in. This can normally be achieved by using a 1: 2: 4 nominal mix. Aggregate should be of 3/4 in. maximum size and should comply with the requirements of B.S. 882. The concrete should have a slump of not more than 3 ins.

41. The concrete should be carefully handled and placed to avoid segregation of the materials. Placing should be completed not more than 45 minutes after mixing. The concrete should be evenly spread over the trench bottom and be adequately compacted to provide a dense, uniform bed. The surface should be kept clean, but in the event of its becoming soiled it should be brushed and washed down with clean water immediately before the pipe laying is commenced.

42. For pipes that can be easily manhandled, the concrete may be laid first to a thickness that would clear the sockets of the pipes when in their final position. When it has set the barrels of the pipes should be tamped to the correct line and level into a bed of newly-mixed concrete, of sufficient width to support and locate the pipes, placed on the concrete already laid and extending the length of the exposed barrels. The concrete into which the pipes are tamped must be workable and its water content carefully controlled. If it is too wet there will be further settlement after tamping and if too dry its ultimate strength may be impaired. After the line has been tested the remainder of the concrete should be placed and tamped solid. Subject to the above requirements, this remaining concrete should be placed as soon as practicable after the concrete bed, so as to ensure as good a bond as possible between the two.

43. For pipes which are too heavy to be laid as described above, the concrete may be laid first to a thickness that would clear the sockets of the pipes when in their final position. The pipes should then be supported clear of the concrete on folding wedges placed under each pipe immediately behind the socket; further wedges near the spigot may be necessary where long pipes are used. Concrete should then be carefully worked under the pipes, ensuring that no voids are left below the two lower quadrants. Wedges should preferably be removed.

44. The total thickness of concrete below the barrels of the pipes should be not less than 4 ins. for 4 in. diameter pipes and 6 ins. for 6 in. and 9 in. diameter pipes. Where concrete bed or concrete bed and haunch are being provided the concrete should extend at least 6 ins. on either side of the pipes. Concrete bed should be carried up to at least one quarter of the height of the pipes. Concrete bed and haunch should be carried up to at least one half of the height of the pipes. In each case the top of the concrete may be horizontal or may be splayed upwards towards the pipe to any extent considered desirable. Where concrete surround is being provided, it should have the same minimum thickness as the concrete beneath the barrel of the pipe.

45. There is no objection to the concrete being carried to the trench walls if this will facilitate construction.

46. Where pipes with mechanical joints are used, vertical construction joints giving a gap of at least 1/2 in. should be formed in the concrete bed or surround to ensure flexibility of the pipeline as a whole. They should be formed at intervals of not more than about 16 ft., but always at a pipe joint. Care must be taken to ensure that movement at these points is not prevented by concrete finding its way into the gap between spigot and socket. The material used for forming the construction joint in the bed should be carried up and shaped round the spigot and should abut on the end of the socket.

47. Before backfilling it is necessary to allow the concrete bed to set sufficiently to attain the strength required to bear the loads to be imposed on it during and immediately after backfilling of the trench. The strength required will vary according to the depth of the pipes, the method of compaction of backfilling to be employed, and the traffic likely to be imposed on the trench immediately. Only limited information is as yet available on the supporting strength provided by concrete bedding at various stages of setting. For the present as a general guide it is suggested that, apart from a layer of about 6 ins. to protect the concrete from frost, backfilling of the trench should not be commenced until at least 24 hours after placing of the concrete has been completed. Under normal circumstances heavy rammers should not be used and traffic loads should not be imposed on the trench until at least 72 hours after the concrete has been placed. In circumstances where it is essential to open the road to traffic earlier special precautions should be taken, such as the use of rapid-hardening cement for the concrete or the provision of steel bridge plates over the trench.

48. When the concrete has acquired the requisite strength, selected excavated material, from which stones over 1 in. in size and lumps of clay have been removed, should be carefully placed and compacted in 4 in. layers up to a minimum height of 12 ins. above the crown of the pipes or the top of the concrete surround as the case may be.

49. Generally the use of concrete with flexible pipes is wasteful since it converts a flexible pipeline into a rigid beam which may fracture under minor ground movement. For flexible pipes with more than 2 ft. of cover concrete is normally unnecessary, but where the cover is less than 18 ins. elsewhere than under roads, narrow concrete slabs on a cushion of filling material above the pipe should be used as protection against picks etc. Where flexible pipes are laid at shallow depths under roads etc. special consideration should be given to all the engineering factors involved, such as the traffic on and the construction of the road, and the proximity of other services. At or above ground level concrete surround should be used to protect flexible pipes.

(iv) *Natural trimmed bottom*
(*to be used only in suitable circumstances and only for rigid pipes*)

50. The preparation of the natural bottom of the trench so that it will provide uniform support for the pipe requires skill and care even in favourable conditions. Shortage of skilled labour, too hard or too soft ground, wet conditions, or longitudinal curvature of individual pipes (even within the permis-

sible limits of the relevant British Standard Specifications) increase the difficulties of this method of bedding. In practice the risk of non-uniform support is greater than with other beddings and in the Working Party's opinion, except with iron pipes, this method of bedding

(a) is not well adapted to the current trend of modern constructional techniques;

(b) should be used only where a constant high standard of workmanship and supervision can be guaranteed;

(c) should be used only where dry conditions can be achieved and where the subsoil is such that accurate hand trimming is practicable;

(d) should only be used with pipes that have mechanical joints, which it is hoped will become universally available before long.

51. Iron pipes of all diameters covered by this note have much greater resistance to crushing than pipes of other materials in general use and may be laid on the natural trimmed bottom in most circumstances provided that reasonable care is taken in construction.

52. The trench bottom should be trimmed as accurately as is practicable; hand trimming will be necessary except in the most rare conditions. All hard spots such as boulders and tree roots should be removed. If the trench bottom is accidentally overdug, it should be made good with excavated or granular material, carefully compacted. Socket holes should be as short as practicable and should be cut in the bottom deep enough to prevent the sockets of the pipes bearing on the bottom.

53. Disturbance of the bottom after it has been trimmed should be avoided; it may be more satisfactory to carry out the final trimming as each individual pipe is laid. The pipes should be carefully laid so that the barrels rest evenly on the bottom and are uniformly supported throughout their length. Adjustments should not be made by local packing under the pipes.

54. After the pipes have been laid and tested, selected excavated material from which stones over 1 in. in size and lumps of olay have been removed, should be carefully placed around the pipes and be thoroughly compacted in 4 in. layers by careful tamping. This material should be carried up to a minimum height of 12 ins. above the crown of the pipe.

(d) Jointing the pipes

55. Mechanical joints should be made strictly in accordance with the instructions of the manufacturers, who will in many cases be prepared to arrange for a demonstration of the proper method of making the joints they supply. All components of the joints must be carefully cleaned before the joints are made. Only lubricants recommended by the manufacturers should be used. In making the joints care should be taken to avoid disturbance of the bedding beneath the pipe barrels.

56. Where rigid joints have to be used the cement mortar should not be too rich and should preferably consist of 1 part cement to 3 parts sand.* The spigot of each pipe should be placed in the socket of the previously laid pipe and adjusted and fixed in its correct position with the spigot accurately centred in the socket. The spigot and socket should be thoroughly wetted. A ring of tarred rope yarn or a prefabricated joint ring should be inserted in the gap between spigot and socket and driven home with a wooden caulking tool and mallet. The yarn when in position should not occupy more than one-quarter of the total depth of the socket. The socket should then be completely filled with cement mortar and a fillet of mortar should be formed, which should be bevelled off at an angle of 45 degrees. The interior of the pipes should be examined as each joint is made and any intrusion of yarn or mortar removed. Newly made joints should be kept damp and protected from the sun and wind. They should not be disturbed and pressure tests should preferably not be applied for at least 24 hours (longer in cold weather) after the joints have been made.

(e) Backfilling

57. Normal filling of the trench above the levels specified in paragraphs 32, 48 and 54 should proceed in layers not exceeding 12 ins. in thickness, each layer being well compacted. Heavy mechanical rammers should not be used until the fill has reached a depth of 12 ins. above the top of the pipes. Where practicable trench sheeting should be withdrawn as backfilling proceeds.

58. Special consideration and selection and compaction of backfilling material will be necessary if the risk of surface subsidence is an important consideration, for example under roads.

House drainage

59. The drainage system immediately adjacent to a building will require careful consideration. It will generally be shallow and will be subject to heavy vehicular traffic during construction of the building. The trenches may be close to or may cross the trenches carrying other utility services such as water, electricity, gas etc. It is probable therefore that if granular bedding is used the risk referred to in paragraph 21, i.e. disturbance of the trench after construction, may arise. Other factors to be taken into account are the lengths in which pipes of different materials are made and the number of joints needed; and the availability of a large range of drainage fittings such as bends, channels, gullies, traps etc. It may well be found that a mixture of materials will be the cheapest. Flexibility is of great importance in house drainage particularly where the drains leave the building and enter and leave manholes.

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* Too weak a mix may lead to sweating at the joint under test; this should be avoided if possible, but slight sweating is preferable to the cracking which may result with too rich a mix.

Appendix

Tests for suitability of soil material for use as bedding for small-diameter sewer and drain pipes laid underground.

(a) Particle size

The maximum particle size should generally not exceed ¾ in. The presence of an occasional particle between ¾ in. and 1½ ins. is acceptable provided the total quantity of such particles is only a very small fraction of the whole. If particles over 1½ ins. are present the material should be rejected.

In cases of doubt a weighed representative sample* of material (about 5 lbs.) should be sieved†, using ¾ in. and 1½ ins. B.S. sieves. If (i) any particles are retained on the 1½ ins sieve, or (ii) more than 5% by weight of the sample is retained on the ¾ in. sieve, the material is not acceptable, unless it is first screened so as to comply with this requirement.

(b) Ease of compaction

Apparatus required:

1. Open-ended cylinder 10 ins. long and 6 ins. ± ¼ in. internal diameter (6 in. diameter pipe is suitable);
2. metal rammer with striking face 1½ ins. diameter and weighing 2 to 2½ lbs.;
3. rule.

Method:

Obtain a representative sample* more than sufficient to fill the cylinder (viz. about 25 lbs.). It is important that the moisture content of the sample should not differ materially from that of the main body of material at the time of its use in the trench.

Place the cylinder on a firm flat surface and gently pour the sample material into it, *loosely and without tamping*. Strike off the top surface level with the top of the cylinder and remove all surplus material. Lift the cylinder up clear of its contents and place on a fresh area of flat surface. Place about one quarter of the material back in the cylinder and tamp vigorously until no further compaction can be obtained. Repeat with the second quarter, tamping as before, and so on for the third and fourth quarters, tamping the final surface as level as possible.

Measure down from the top of the cylinder to the surface of the compacted material. This distance in inches divided by the height of the cylinder (10 inches) is referred to as the Compaction Fraction.

Compaction Fraction	*Suitability for use*
0·1 or less	Material suitable.
0·1 to 0·3	Material suitable but requires extra care in compaction. Not suitable for flexible pipes subject to waterlogged conditions after laying.
Over 0·3	Material unsuitable.

Notes.

*To obtain a representative sample about 1 cwt. of the proposed material should be heaped on a clean surface and divided with the spade down the middle into two halves. One of these should then be similarly divided, and so on until the required weight of sample is left.

†In the sieving, clumps of material that break up under light finger pressure may be helped through the sieve, but considerable force must *not* be used to squeeze oversize clumps through the mesh.